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ABSTRACT

The relative importance of visual and auditory information in judging student comprehension during a reading lesson was tested by having 42 adult subjects observe videotape recordings of reading lessons with individual children and estimate student comprehension with visual information only, auditory information only, or both visual and auditory information. The dependent variable was the accuracy of the estimates as measured by their agreement with the students' self-reported comprehension. Results showed that the greatest accuracy of decoding occurred in and visual-only condition, with the auditory-visual condition yielding significantly less accuracy, and with the lowest accuracy in the auditory-only condition. (Author/RL)

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Technical Report No. 507

THE ROLE OF VISUAL AND AUDITORY CUES IN DECODING COMPREHENSION

by

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Report from the Project on
Studies of Instructional Programming for the Individual Student

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Abstract

Two competing hypotheses were tested concerning the relative importance of visual and auditory information in judging degree of comprehension of a stimulus child learning a lesson. Adult subjects estimated the student's level of comprehension from observing a videotape recording. Three experimental conditions were employed: (a) visual information only, (b) auditory information only, and (c) both visual and auditory information. The dependent variable was accuracy of the estimate of the student's comprehension, measured by the degree of agreement with the student's self-reported comprehension. Results showed that the greatest accuracy of decoding occurred in the visual-only condition, with the auditory-visual condition yielding significantly less accuracy, and with the lowest accuracy in the auditory-only condition.

Visual and auditory channels constitute the two basic sensory modalities that are used for accomplishing accurate social communication. Previous research dealing with the encoding and decoding of emotion is rather extensive, but available literature sheds little light on the differential contribution of visual and auditory cues in the decoding process. Past research on accuracy of communication has been concerned primarily with affective rather than cognitive states. Moreover, most available studies have examined parameters within either the visual or auditory modality (Birdwhistell, 1968; Davitz & Davitz, 1957; Ekman, Friesen, & Ellsworth, 1972; Frijda, 1969; Haggard & Isaacs, 1966). Only a few studies have made comparisons across modalities (Bugental, Kazwan, & Love, 1970; Leavitt, 1964; Mehrabian & Ferris, 1967).

Apparently, only two studies have attempted to compare experimentally the relative impact of visual and auditory channels, and the two experiments yielded conflicting results. One study found the lowest accuracy of person perception in the auditory-only condition (Berman, Shulman, & Marwit, 1976), whereas the other found least accuracy in the visual-alone condition (Jecker, Maccoby, Breitrose, & Rose, 1964).

In the Berman et al. (1976) study the subjects decoded stimulus films of adult encoders reading instructions for filling out a questionnaire. Instead of measuring accuracy of subjects' judgments (vis-a-vis self-reports of stimulus persons), this study only measured the intersubjective reliability of subjects' ratings on each of the 11 dimensions of

the Nowlis Mood Adjective Checklist. The reliability, expressed as correlation coefficients, was the dependent variable of the study. The independent variable--mode of communication--was manipulated by creating three experimental treatments (visual information only, auditory information only, and visual plus auditory information). Overall, results showed that the audio-only condition yielded significantly lower reliability than the video-only and audio-video conditions. The latter two conditions did not differ substantially for most of the 11 dependent measures. These results have limited implications for the present study for three reasons. First, stimulus persons were adults reading scripts rather than children in a learning situation. Second, most of the dimensions on the Nowlis Mood Adjective Checklist deal with affective rather than cognitive states. And, third, intersubjective reliability, which the authors interpret as measures of accurate decoding, was the dependent variable rather than degree of agreement between subjects' ratings and self-reports of stimulus persons. Nevertheless, one dimension of the checklist (concentration) bears some resemblance to a cognitive state. Results for this dependent measure showed the highest reliability in the video-only condition (.68), lower reliability in the audio-video condition (.29), and the lowest reliability in the audio-only condition (.03). This pattern of results weakly supports the suggestion that information from the auditory channel interferes with or distracts from the process of perceiving cognitive states.

Results from the Jecker et al. (1964) study support an opposing hypothesis. In this study adult decoders judged the comprehension of stimulus children who had been filmed while naturally encoding their reactions

to a lesson in mathematics. Short segments of film depicting understanding or not understanding were spliced together in random order. A stimulus film consisting of these randomly ordered segments was presented to subjects who rated the student's comprehension for each segment. The dependent variable was the frequency of accurate ratings made by subjects. The independent variable was mode of communication, which was manipulated in exactly the same manner as in the Berman et al. (1976) study. Subjects in the auditory-only and auditory-visual conditions accurately decoded a greater number of segments than would be expected by chance. But subjects in the visual-only condition were no more successful in decoding comprehension than would be expected by chance. This pattern of results supports the suggestion that information from the visual channel is irrelevant to (and potentially distracts from) the process of perceiving cognitive states.

Although these two experiments differed somewhat with respect to stimulus materials and dependent measures, they lead to competing predictions for accuracy of comprehension. The Berman et al. (1976) study supports the hypothesis that accuracy of perception is based primarily on visual cues, and that auditory information is irrelevant and distracting. On the other hand, the Jecker et al. (1964) study supports the hypothesis that accuracy of decoding is based primarily on auditory cues, and that visual information is irrelevant and distracting.

The present study tests these competing predictions in the context of perception of a student's degree of comprehension. In the present experiment subjects estimated a student's level of comprehension from

observing videotape recordings. The study investigated the effect on decoding accuracy of three types of information from the student: (a) visual information only, (b) auditory information only, or (c) both visual and auditory information. An estimate of the student's level of comprehension is one dependent variable. A second important dependent variable is the accuracy of impression about the student. Accuracy was determined by degree of agreement between the subject's estimate and the student's self-reported comprehension.

Method

Subjects

Subjects were 42 undergraduates (21 males and 21 females) who participated in exchange for credit in an introductory psychology course at the University of Wisconsin. An equal number of male and female subjects was randomly assigned to each of the three experimental conditions.

Stimulus Materials

Videotape recordings (with sound) were made of two children being taught by a female adult teacher who was off the screen. A 9-minute lesson was prepared for a concept formation task similar to the task employed by Garbarino (1975). The lesson taught the child how to play a "game" that involved matching three dimensions of a set of chips to printed symbols on a gameboard according to a code. The chips varied on three dimensions: (a) color (red, white, and blue), (b) size (large, small), and (c) marking (a dot, an X, or a square on the face of each chip). The gameboard was divided into 24 blocks, and each block contained a set of three symbols which corresponded to the same dimensions as the chips. The object of the game was to correctly place each chip on the appropriate block of the gameboard.

The lesson was taught in six distinct segments by an adult female teacher. The teacher was carefully trained to present each segment in a standard way, keeping constant tone of voice, pace of recitation, and eye contact with each student. The lesson was well rehearsed prior to videotaping in order to maximize the amount of eye contact between teacher

and student.

Videotapes were made of several second-grade students while each was being taught. The student was seated at a table across from the teacher, and received instructions about the nature of the lessons and the use of a rating scale to indicate degree of comprehension after hearing each segment of the lesson. To encourage the children to make their self-reports of comprehension as valid as possible, the experimenter stressed the importance of complete honesty and stated that a short test would be administered after each segment of the lesson.

Videotaping was accomplished by the experimenter from another room through a one-way mirror. The student (who was not aware of being videotaped) faced the camera at approximately a 45° angle, and the seating arrangement provided that the teacher was offscreen. Between each segment of the lesson the experimenter stopped the videotape to obtain the student's self-reported understanding for the preceding segment. When all six segments had been videotaped, the experimenter described the nature of the study to the children. Videotapes of two of the students (one male and one female) were selected as stimulus material for the present study.

Design

Three experimental conditions were used to manipulate mode of information about the target children: (a) visual-only, (b) auditory-only, and (c) auditory-visual. In the visual-only condition the soundtrack was silenced while subjects were observing the videotape of the two stimulus children on a 23-inch television monitor; this was

accomplished by turning the volume switch on the monitor to zero. Subjects in this condition simply watched each child as he or she was listening to the lesson.

In the auditory-only condition subjects listened to the soundtrack of the videotape; the visual image on the television monitor was concealed. This was accomplished by placing a wooden barrier in front of the monitor (completely obscuring the screen from view), with the volume turned up to a comfortable level. Subjects in this condition listened to the teacher presenting the lesson to each stimulus child.

In the auditory-visual condition subjects both watched and listened to the videotape of each stimulus child. Subjects were seated in front of the television monitor and viewed the picture of each child while simultaneously hearing the teacher's presentation.

Procedure

Upon arriving at the experimental room, the subject was seated before a television monitor that provided the appropriate kind of stimulus information. Subjects were told that the experiment concerned interpersonal communication by children in a learning situation, and that they would either see, hear, or see and hear videotapes of two children listening to an identical lesson given by the same teacher. Subjects were told to carefully monitor all six segments of each child's videotape on a moment-to-moment basis in order to judge each child's overall level of comprehension for each segment. After subjects had received instructions on using the rating scale and had indicated they understood the task, the experimenter presented the first segment of the first child's lesson. When the segment was completed the experimenter asked the subject

to rate the overall level of comprehension of the stimulus child during the segment. This procedure was repeated for the remaining five segments of the first stimulus child and for the six segments of the second child. During the presentation of stimulus materials the experimenter remained behind a room divider, only appearing between segments to collect the subject's overall assessment of comprehension. At the end of the experimental session a postexperimental questionnaire was administered to each subject.

Presenting the videotapes and collecting overall ratings required approximately 40 minutes. Because many subjects complained of boredom and fatigue, statistical analysis was limited to data collected during the first lesson segment of each stimulus child. These data should be least contaminated by extraneous factors.

Method of Analysis

The subjects' judgment of the stimulus children's absolute level of comprehension was measured by the response to the question, "Overall, how much did this child understand during the first segment of the lesson?" A 10-point Likert scale was used, ranging from "understood nothing" to "completely understood."

The subject's accuracy in judging comprehension was also measured. While stimulus materials were being prepared each stimulus child provided a self-report of his or her comprehension during the first segment of the lesson ("Overall, how much did you understand the first segment of the lesson?"). The 10-point Likert scale ranged from "understood nothing" to "completely understood." A subject's accuracy in judging comprehension was defined as the absolute difference between the stimulus child's

response to this question and the subject's response to the parallel question.

Data were subjected to a 3 x 2 between-subjects analysis of variance, with factors being three modes of information (visual-only, auditory-only, and auditory-visual) and sex of subject (male, female).

Results

Table 1 presents results of an analysis of variance performed on the subjects' accuracy scores for judging the comprehension of stimulus children. A significant main effect was found for mode of presentation, F (2, 36) = 20.14, $p < .001$. Subjects in the auditory-only condition were least accurate in judging the students' comprehension (M = 3.50); subjects in the auditory-visual condition were somewhat more accurate (M = 2.80); and subjects in the visual-only condition were most accurate of all (M = 1.43). (Smaller means indicate greater accuracy.) A Fisher's post hoc LSD test showed that these three means differed significantly from one another ($p < .05$). No main effect of sex of subject and no interaction effect were observed for this measure.

The results of the analysis of variance performed on subjects' data for absolute level of comprehension of the stimulus children are presented in Table 2. A significant main effect was found for mode of communication, F (2, 36) = 3.92, $p < .05$. Subjects in the auditory-only condition gave the highest estimate of comprehension (M = 7.17); subjects in the auditory-visual condition made lower estimates of understanding (M = 6.77); and subjects in the visual-only condition made the lowest estimate of understanding (M = 5.48). Post hoc tests of these means by Fisher's LSD showed that the visual-only condition yielded significantly ($p < .05$) lower estimates of comprehension than either the auditory-only or the auditory-visual conditions. The auditory-only and the auditory-visual conditions did not differ significantly. No main effect of sex of subject

Table 1

Analysis of Variance on Accuracy Scores

Source	df	MS	F
Mode of communication (A)	2	15.55	20.14*
Sex of subject (B)	1	.18	.23
A x B	2	.48	.62
Error	36	.77	--

*$p < .001$.

Table 2

Analysis of Variance on Absolute Estimates of Understanding

Source	df	MS	F
Mode of communication (A)	2	11.23	3.93*
Sex of subject (B)	1	2.62	.91
A x B	2	.66	.23
Error	36	2.88	--

*$p < .05$.

and no interaction effect were found on this measure.

One finding from the postexperimental questionnaire warrants mentioning. In response to a question about the amount of attention given to how difficult the lesson sounded, subjects in the auditory-only condition reported paying significantly more attention (M = 6.71) than subjects in the auditory-visual condition (M = 5.78), t (26) = 2.49, p < .05. (This question could not be asked, of course, in the visual-only condition.) When related to the accuracy data, this finding is consistent with the hypothesis that relying on auditory information alone may lead to inaccurate judgments about comprehension.

Discussion

The present study provided clear support for the notion that perception of comprehension is based primarily on visual information in the form of nonverbal behavior from the student. This evidence directly confutes the best previous research on perception of comprehension (Jecker et al., 1964) from which the opposite prediction was derived. Instead, the interpretation stemming from the more dissimilar study by Berman et al. (1976) on decoding affect was supported. According to this interpretation, auditory cues may be irrelevant and even distracting to accurate person perception. Such a conclusion is particularly cogent in the present study for two reasons: (a) The auditory-only condition not only produced least accurate perception of comprehension, but the auditory-visual condition was significantly less accurate than the visual-only condition; and (b) data from the postexperimental questionnaire indicated that subjects in the auditory-visual condition paid less attention to auditory cues than subjects in the auditory-only condition. This pattern of results suggests that cues from the auditory channel were not merely irrelevant, but in fact a distraction to the process of accurately perceiving comprehension. The order of means for the absolute ratings of comprehension (i.e., significantly lower comprehension in the visual-only condition than in the audio-only and audio-visual conditions) suggests that information stemming from hearing the lesson led subjects to overestimate the comprehension of the students.

The present results differ sharply from the earlier findings of

Jecker et al. (1964). One possible explanation for the discrepancy rests with differences in the nature of the stimulus materials in the two studies. In the Jecker et al. study, auditory information consisted of question-and-answer-type exchanges between teacher and student. In contrast, auditory information in the present study consisted primarily of the content of a lesson presented by the teacher. It is possible that this information alone, in the absence of auditory cues from the student, leads to mistaken inferences that a question and answer sequence would correct. Future research might profitably examine the effect of three types of auditory information (i.e., student utterances, student-teacher exchanges, and teacher's speech) for their contribution to, or detraction from, accuracy of decoding student comprehension when they accompany a constant level of nonverbal cues.

In summary, results from the present study supported the hypothesis that visual cues contribute to accurate perception of comprehension, and that auditory cues from the teacher reduces accuracy. Two explanations can be offered to account for the present findings. First, auditory cues from the teacher may be irrelevant to perceiving student comprehension and serve only as a distraction from the more meaningful visual information. A second explanation suggests that by relying on information concerning the content of a lesson subjects make an unwarranted assumption about the ease with which such content is learned by second-graders. The finding is consistent with previous research showing the relative importance of nonverbal behavior over content and paralinguistic aspects of speech (Mehrabian & Ferris, 1967; Zaidal & Mehrabian, 1969). Previous

research has established this principle primarily for the perception of affective states, but the present study extends the finding to the perception of cognitive states.

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